KINGMAN AREA
MASTER DRAINAGE PLAN

EXECUTIVE SUMMARY

June 1988

BOYLE ENGINEERING CORPORATION

consulting engineers / architects

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June 20, 1988

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KINGMAN AREA MASTER DRAINAGE PLAN

In accordance with the Scope of Work for the Kingman Area Master Drainage Plan, we have pleasure in submitting herewith the final report. The report is presented in a number of study documents: the Executive Summary gives the most important findings of the study; the Master drainage Plan contains the report findings and alignments, sections and grades of proposed channels; Appendices Volume 1 contains the hydrology and hydraulic details; Appendices Volume 2 contains the Bull Mountain Basin and the Southeast Area Drainage Studies and the final document contains the Drainage Design and Administrative Manual.

Reproducible mylars and computer tapes of new topographical mapping have been submitted under separate cover.

The study shows that the most effective means of mitigating the effects of stormwater flooding in the Kingman Area is to establish drainage corridors and construct channel improvements. A diversion of all flows from east of the AT&SF Railroad to downstream of current development will provide the single best measure to reduce current problems.

We would like to record our appreciation to the City of Kingman and Mohave County for having been invited to participate in the study and to the personnel who have co-operated so willingly and who have greatly assisted in the successful completion of the study.

BOYLE ENGINEERING CORPORATION

Kenneth V Lewis

Kenneth V. Lewis, P.E.

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PREFACE

In March 1987 the City of Kingman contracted with Boyle Engineering Corporation to prepare a Master Drainage Plan for the greater Kingman Area. The work was to include a Drainage Design and Administrative Manual, A Master Drainage Plan, a more detailed analysis of the Bull Mountain Drainage Basin, and an Executive Summary of the entire project.

The results of the study are presented in the following documents:

Executive Summary	
Master Drainage Plan	
Appendices - Volume 1	Hydrology/Hydraulic Details
Appendices - Volume 2	Bull Mountain Basin Southeast Area Drainage
Design and Administrative Manual	

This document is the Executive Summary.

Registered Professional Engineer (Civil)
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KENNETH V.
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ARIZONA, U.S.A.
6/20/88

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1. INTRODUCTION

The City of Kingman and surrounding environs has developed without full consideration to the drainage needs of the area. This has resulted in public inconvenience and flood damage to both public and private property. To guide future development and mitigate flooding in existing areas, City of Kingman and Mohave County officials identified the need for a comprehensive Master Drainage Plan.

2. STUDY PROCEDURE

Throughout the master planning process, ongoing communication with the City of Kingman and Mohave County has resulted in a plan which is responsive to their various needs. The study procedure included:

- Preparing a drainage design and administrative manual to provide direction and specific requirements for the evaluation and design of drainage facilities.
- New aerial mapping for selected areas.
- Preparing a detailed study for Bull Mountain Basin to address drainage needs for proposed roadway improvements along Stockton Hill Road.
- Establishing major drains and the responsibility for their design, construction and maintenance.
- Reviewing historic flooding areas.
- Reviewing alternative drainage considerations.
- Preparing proposed drainage alignments, sections, profiles and planning cost estimates.

3. EXISTING CONDITIONS

The study area shown on Exhibit 1 contains 72 square miles and includes the Mohave Channel and Johnson Canyon Basins. The Mohave Channel Basin has a drainage area of 168 square miles and extends to the Hualapai Mountains on the southeast and the Cerbat Mountains on the west. Johnston Canyon Basin has a drainage area of 12 square miles within the study area including the developed downtown area.

Runoff in the Mohave Channel Basin from the Hualapai Mountains is restricted by the AT&SF Railroad and US-66. Several culverts under the railroad concentrate flow resulting in downstream flooding. This is primarily due to to inadequately sized outlet facilities.

Runoff from the Cerbat Mountains in the west travels swiftly, transporting sediment and boulders in defined washes. Further downstream on the alluvial fan, velocities decrease and washes tend to be laterally unstable. Runoff crosses Stockton Hill Road in dipped sections and continues to the Mohave Channel. With reference to Figure 1, the flooding areas in the Mohave Channel Basin include:

1. Fairgrounds Boulevard - Runoff from east of AT&SF Railroad and contributing adjacent side streets flows down Fairgrounds Boulevard to the County Fairgrounds. There are no drainage facilities to manage the runoff.

2. Bank Street - Bank Street is the drainage system for a large area east of the railroad and adjacent side streets. High flows frequently and severely flood the road with runoff eventually finding its way to the Mohave Channel.

3. Stockton Hill Road - Runoff from the Cerbat Mountains frequently floods a number of locations along Stockton Hill Road. The most serious is in the vicinity of Gordon Drive.

4. Sunrise and Western Avenue - Runoff from the mountain behind the golf course together with increased runoff from new development is creating problems in this area.

Runoff from the downtown area flows to the south crossing Andy Devine Avenue and the AT&SF Railroad and enters Holy Moses Wash. Development upstream of the railroad is almost complete and should not aggravate downstream conditions. Streets in the downtown area are wide with high curbs and are generally adequate to handle storm runoff; however with reference to Figure 2, the following areas experience flooding:

1. First Street and Andy Devine Avenue - Flows from side streets north of Andy Devine Avenue combine with street flow in Andy Devine Avenue and pond at First Street. The intersection is frequently impassable during storms.

2. Eighth Street Underpass at the AT&SF Railroad - Runoff from upstream of Eighth Street, flow west along the railroad and pond in the underpass. A small pipe and channel draining the underpass are undersized.

3. Sixth Street south of the AT&SF Railroad - During heavy storms, floodwaters reach Park and Golconda Streets then continue southwest and flood the S&S Apartments at Old Trails Road and Golconda Street.

4. High School - Stockton Hill Avenue carries flow from an upstream wash to the high school parking lot and then to the athletic field. The runoff eventually exits the athletic field via a drain under Andy Devine Avenue.

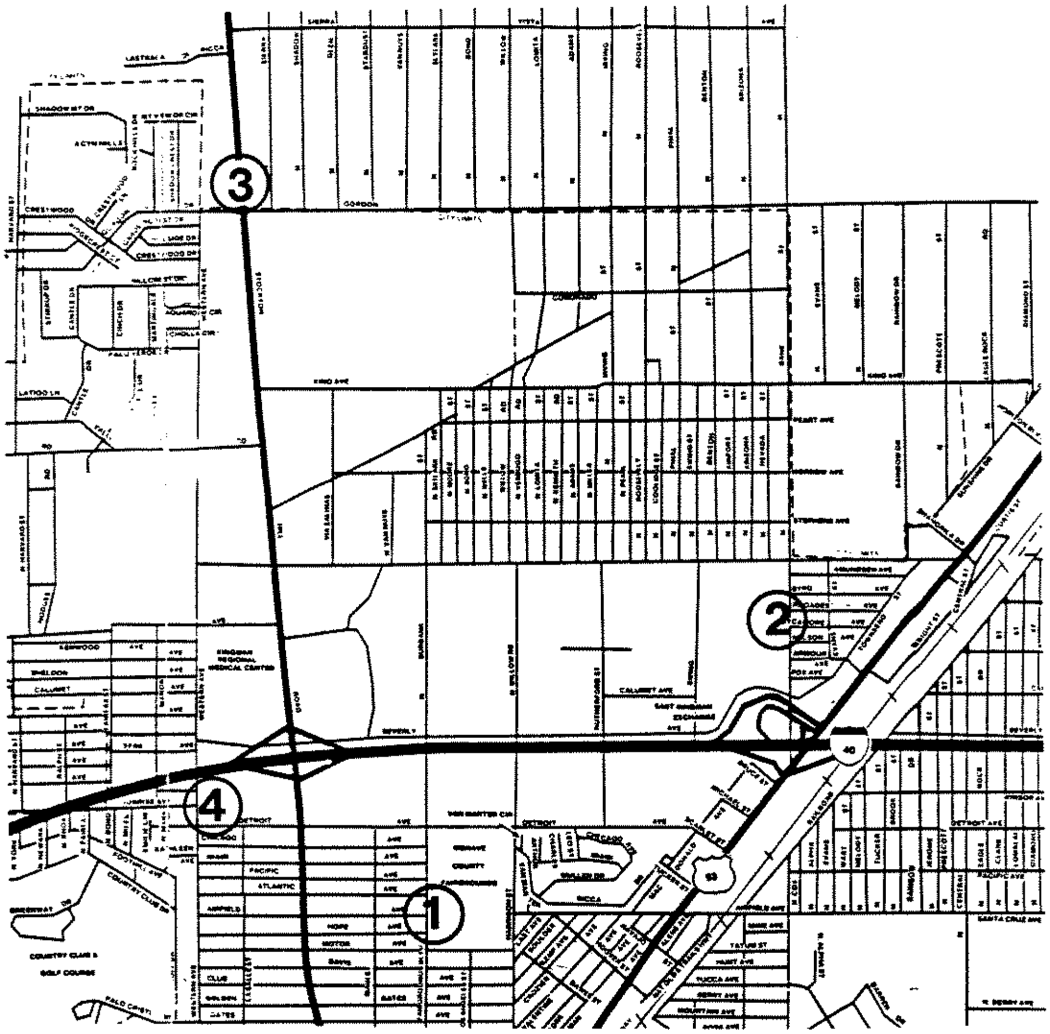

Figure 1 Mohave Channel Basin Flooding Areas

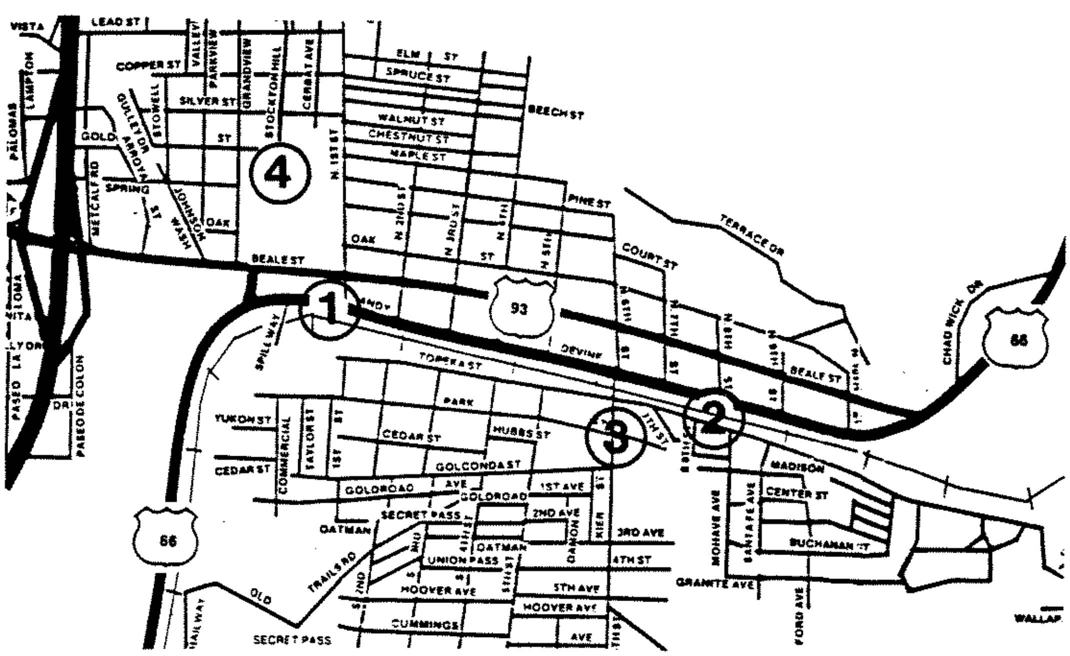

Figure 2 Downtown Flooding Areas

4. BASIS OF DESIGN

Major drainageways identified have been sized to convey the 100 year runoff without overtopping. Drainage problems within existing development vary and are site specific and no generic level of protection or type of solution is proposed.

The hydrologic evaluation of the Kingman area was performed using the SCS Method within HEC-1. The delineation of subbasins (Exhibit 2) and the development of basin characteristics were obtained from available topographic maps and soil surveys. The rainfall distribution chosen for this study was a 3-hour distribution based on the Indio (California) area thunderstorm of September 24, 1939. Point precipitation values were obtained from published data for the Kingman Gage.

The hydraulic evaluation for channels within the study area was accomplished using STORMPLUS a proprietary modification of the Los Angeles County Water Service Profile Computer Program.

The 100 year runoff will generally flow at erosive velocities in the proposed unlined channels. Critical channel reaches where failure might pose a serious threat to life or property will be lined with concrete or soil cement. In less critical reaches where scour can be tolerated without catastrophic consequences, channels have been proposed which have low velocities during frequent storms (2-year) but will experience some scour during less frequent storms, such as the 10-year to 100-year storms.

Channel maintenance will be required after major storm events where scour occurs and is considered a more reasonable solution than to line all major drainageways. Liberal setbacks up to 100' for buildings outside of channel right-of-way or local embankment protection will reduce the potential for major property damage.

5. ALTERNATIVE CONSIDERATIONS

Alternative drainage considerations were reviewed with City and County staff with infeasible options eliminated from further consideration. Concentrated effort was then directed toward the evaluation of the preferred solution to develop the components necessary for the final Master Drainage Plan. Five drainage elements were considered as part of this study:

1. Major Drainageway Alignment
2. Detention Storage
3. Conveyance Systems
4. Channel Crossings
5. Diversions

5.1 Major Drainageway Alignment

The alignment of major drainageways was selected based on existing alignments and new reasonably spaced drainage corridors. The proposed channels are shown in Exhibit 3.

The Mohave Channel follows the general alignment of the existing channel with minor deviations to facilitate channel shaping. For most other drains corridors were identified which would serve as the future location for a major drain. These corridors, near section lines, intercept flows generated on the fan above the developed areas and provide a defined outfall for adjacent developments.

5.2 Detention Storage

Detention storage was considered as a means of reducing peak flows and the size of downstream conveyance systems. However no feasible sites were identified for this master plan.

On the east side of the valley, locating a basin at the foothills of the Hualapai Mountains is too distant to significantly reduce peak flows within the study area. Locating facilities on the fan just upstream of the study area is also considered infeasible because of the steep slopes and continued need for an outfall channel. On the west side of the valley basins were infeasible because of relatively wide canyons, steep valleys and underlying hardpan.

5.3 Conveyance Systems

Conveyance systems could be either open channel or closed systems. Closed conduits were eliminated, except in special cases because of their high cost. They are considered more practical for street drainage of minor flows.

The alternatives for open channels include narrow lined or wide unlined sections. The comparison is between right-of-way cost and the cost for channel lining. It is estimated that right-of-way would have to cost at least $50,000 per acre before lined channels would be the more cost effective solution.

5.4 Channel Crossings

Channel crossings are necessary where major streets cross drainageways. Alternatives evaluated include providing a culvert with the capacity of the entire 100-year flow or providing a 10 year culvert capacity with street overflows capable of conveying the 100-year runoff.

The 100 year runoff ranges from 2-4 times the 10 year runoff. This means that culverts conveying the 100 year runoff without overtopping the road will cost about 2-4 times the 10 year culvert. The level of protection to be afforded a particular road crossing should be based on the road importance and available funds. For this study we have assumed culverts with a capacity to convey the 10 year storm will be constructed at section line crossings. At other roads dipped crossings will be maintained.

5.5 Diversions

Early in the study, alternatives were reviewed to relieve the flooding along Fairgrounds Boulevard and Bank Street. A diversion channel was proposed and agreed on along the east side of the AT&SF Railroad line extending from the Getz Station northward to a point south of the airport entrance. This diversion channel will collect flows from the upstream drainage area and bypass the developed areas west of the railroad tracks. Fairgrounds Boulevard, Bank Street and the Mohave Channel will experience the most significant reductions in storm flows. Table 1 estimates the peak flow reduction at key locations with and without the proposed diversion. (See Exhibit 3 for channel locations).

Table 1 Diversion Channel Impacts on Downstream Flows

Channel Section	100 Year Runoff - (cfs) With Diversion	Without Diversion
Mohave Channel Section 90 - 80	2,144	3,287
Mohave Channel Section 80 - 70	6,909	9,643
Mohave Channel Section 70 - 60	8,364	17,116
Mohave Channel Section 60 - 50	11,910	21,316
Fairgrounds Blvd	130	500
Bank Street	200	2,500

6. PROPOSED IMPROVEMENTS

The proposed improvements developed for major drains within the Kingman area are primarily concerned with preventing future major damage as development intensifies on the alluvial fans. The design of the drainageways has been based on the contributing areas shown in Exhibit 2 and the channel alignments in Exhibit 3. It is important that future development adhere to these basin boundaries and direct their runoff to the appropriate drain.

7. PLANNING COST ESTIMATES

Planning cost estimates have been prepared for the proposed improvements and are presented in Table 2. The costs include estimates of excavation, linings, structures, and right-of-way acquisition. No other components are included therefore, a 25% contingency has been included. The unit costs used in the estimates are as follows:

Earthworks	\$1.25 per cubic yard
Channel Lining	\$4.00 per square foot
Structures	\$60 per cfs
Right-of-Way	\$2,000 - \$15,000 per acre

Table 2 Hydrology/Planning Cost Estimate Summary

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Channel	Drain	Length (ft)	100 Yr Runoff (cfs)	ROW Width (ft)	Channel Cost ($)	Structure Cost ($)	ROW Cost ($)	Contin-gency ($)	TOTAL COST ($)
Mohave Channel	10 - 20	6,300	46,057	785	1,250,754		227,066	369,455	1,847,275
	20 - 30	6,300	37,241	685	1,020,075	715,380	198,140	483,399	2,416,994
	30 - 40	5,900	22,813	485	616,441	457,440	131,382	301,316	1,506,578
	40 - 50	5,600	22,656	485	605,993	914,880	124,702	411,394	2,056,968
	50 - 60	7,700	11,910	285	448,668	574,080	119,318	285,516	1,427,582
	60 - 70	1,500	8,364	230	58,438		13,774	18,053	90,265
	70 - 80	9,200	6,909	200	288,139	532,260	52,801	218,300	1,091,500
	80 - 90	7,900	2,144	125	87,229			21,807	109,036
		50,400			4,375,736	3,194,040	867,183	2,109,240	10,546,199
Line Ad	Ad1 - Ad2	18,400	6,971	220	456,167	550,980	464,646	367,948	1,839,741
	Ad2 - Ad3	5,200	6,373	220	143,650		131,313	68,741	343,704
	Ad3 - Ad4	16,000	5,722	215	306,000	346,440	394,858	261,824	1,309,122
	Ad4 - Ad5	2,000	3,139	150	26,130		34,435	15,141	75,706
	Ad4 - Ad6	2,000	1,018	90	165,750		20,661	46,603	233,014
		43,600			1,097,696	897,420	1,045,914	760,257	3,801,287
Line Ae	20 - Ae2	6,400	9,996	275	240,593	151,314	202,020	148,482	742,408
Line Af	30 - Af2	6,800	14,402	325	366,381	332,820	253,673	238,219	1,191,093
	Af2 - Af3	10,800	14,402	325	518,650	665,688	402,893	396,808	1,984,038
	Af3 - Af6	4,800	622	85	15,333	13,560	46,832	18,931	94,657
		22,400			900,365	1,012,068	703,398	653,958	3,269,788
Line Ag	30 - Ag2	20,000	5,319	170	352,870	528,084	624,426	376,345	1,881,726
	Ag2 - Ag3	11,000	4,271	170	157,361	243,456	343,434	186,063	930,314
	Ag3 - Ag4	3,900	1,983	150	52,451	62,355	107,438	55,561	277,806
		34,900			562,683	833,895	1,075,298	617,969	3,089,845
Line Ah	30 - Ah2	7,200	1,270	115	49,467	60,102	152,066	65,409	327,043
Line Ai	40 - Ai2	7,400	676	90	29,155		122,314	37,867	189,336
Line Aj	40 - Aj2	19,600	422	80	45,915	24,120	287,971	89,501	447,507
Line Ak	50 - Ak2	7,200	697	90	26,833	20,040	148,760	48,908	244,542
Line Am	60 - Am2	7,900	601	90	26,919	22,440	163,223	53,145	265,727
Line An	70 -8474	8,500	2,853	135		76,980		19,245	96,225
	8474- An2	8,500	1,833	125		50,400			50,400
		17,000				127,380		19,245	146,625

NOTES: 1) ROW for Mohave Channel assumes 150' ROW exists between Nodes 50 -90.

Table 2 Hydrology/Planning Cost Estimate Summary

Channel	Drain	Length (ft)	100 Yr Runoff (cfs)	ROW Width (ft)	Channel Cost ($)	Structure Cost ($)	ROW Cost ($)	Contin-gency ($)	TOTAL COST ($)
Line Ao	80 - Ao2	6,400	3,234	135	64,889	92,244	198,347	88,870	444,350
	Ao2 -7200	800	3,234	115	196,778		21,120	54,475	272,373
	7200- Ao3	3,600	2,133	110	736,500		90,909	206,852	1,034,261
		10,800			998,167	92,244	310,376	350,197	1,750,984
Line Ap	Ap1 - Ap2	3,500	379	80	6,951	11,340	96,419	28,678	143,388
Line Bb	200 - Bb2	2,800	1,113	70	105,169		44,995	37,541	187,705
	Bb2 - Bb3	1,600	658-		178,500				178,500
	Bb3 -5000	600	482	60	22,536		8,264	7,700	38,501
	5000-5600	600	482-		66,900				66,900
	5600- Bb4	1,400	482	60	52,584		19,284	17,967	89,835
	Bb4 - Bb5	950	415	60	35,682		13,085	12,192	60,959
		7,950			461,371		85,629	75,400	622,400
Railway Channel	50 - 100	6,200	12,068	215	232,873	253,611	306,015	198,125	990,624
	100 - 110	7,000	7,316	190	213,630		305,326	129,739	648,695
	110 - 120	4,600	3,980	135	69,980		142,562	53,135	265,677
	120 - 130	7,200	2,675	125	80,267		206,612	71,720	358,598
	130 - 140	5,000	1,289	105	33,009		120,523	38,383	191,916
	140 - 150	3,300	300	90	10,328		68,182	19,627	98,137
		33,300			640,086	253,611	1,149,219	510,729	2,553,646
Line Cb	Cc1 - Cb2	8,800	1,782	110	68,322	71,760	177,778	79,465	397,325
Line Cc	100 - Cc1	3,200	4,305	140	45,733	93,801	82,277	55,453	277,265
	Cb2 - Cc2	8,000	1,960	110	55,741		161,616	54,339	271,696
		11,200			101,474	93,801	243,893	109,792	548,961
Line Cd	110 - Cd2	11,200	3,657	135	130,667	98,346	277,686	126,675	633,373
	Cd2 - Cd3	3,200	2,961	150	59,733	86,334	88,154	58,555	292,777
		14,400			190,400	184,680	365,840	185,230	926,150
Line Ce	120 - Ce2	7,200	1,235	105	35,833	33,360	138,843	52,009	260,045
Line Cf	130 - Cf2	10,400	1,444	105	60,041	73,050	200,551	83,410	417,052
Line Cg	140 - Cg2	10,400	1,289	95	48,726	63,360	181,451	73,384	366,921
GRAND TOTAL		341,950			9,966,732	7,220,025	7,718,147	6,152,276	31,057,180

NOTES: 1) Line Bb sections Bb2-Bb3 and sta 5000-5600 are 42" dia RCP.

8. IMPLEMENTATION

The implementation of the proposed improvements must be properly planned and executed to avoid exposing the public to increased hazard. Since the likelihood of simultaneous construction of all facilities is small, a phased approach should be adopted.

The first step in implementing a plan for the construction of improvements is the adoption of this Master Drainage Plan. This establishes the location of proposed drainage corridors and channel sections. The Drainage Design and Administrative Manual should also be adopted and enforced. This establishes procedures for the integration of development into the overall drainage system and provides the City and County with a drainage infrastructure outside of the major drainageways.

In general, drainage improvements must be constructed in a manner which does not expose any property to increased hazard. To satisfy this requirement, the phasing plan must be carefully conceived. Under ideal conditions, this objective can be achieved by beginning the construction of improvements at the downstream limits of the drainageways. This provides the necessary protection to downstream properties without impacting upstream properties. This approach, while satisfying the requirements of not exposing property to increased hazard, does not necessarily provide relief to those properties presently being exposed to flood hazard. A more reasonable approach is to provide improvements in areas where development is taking place and to carefully evaluate the impacts of those improvements on downstream properties.

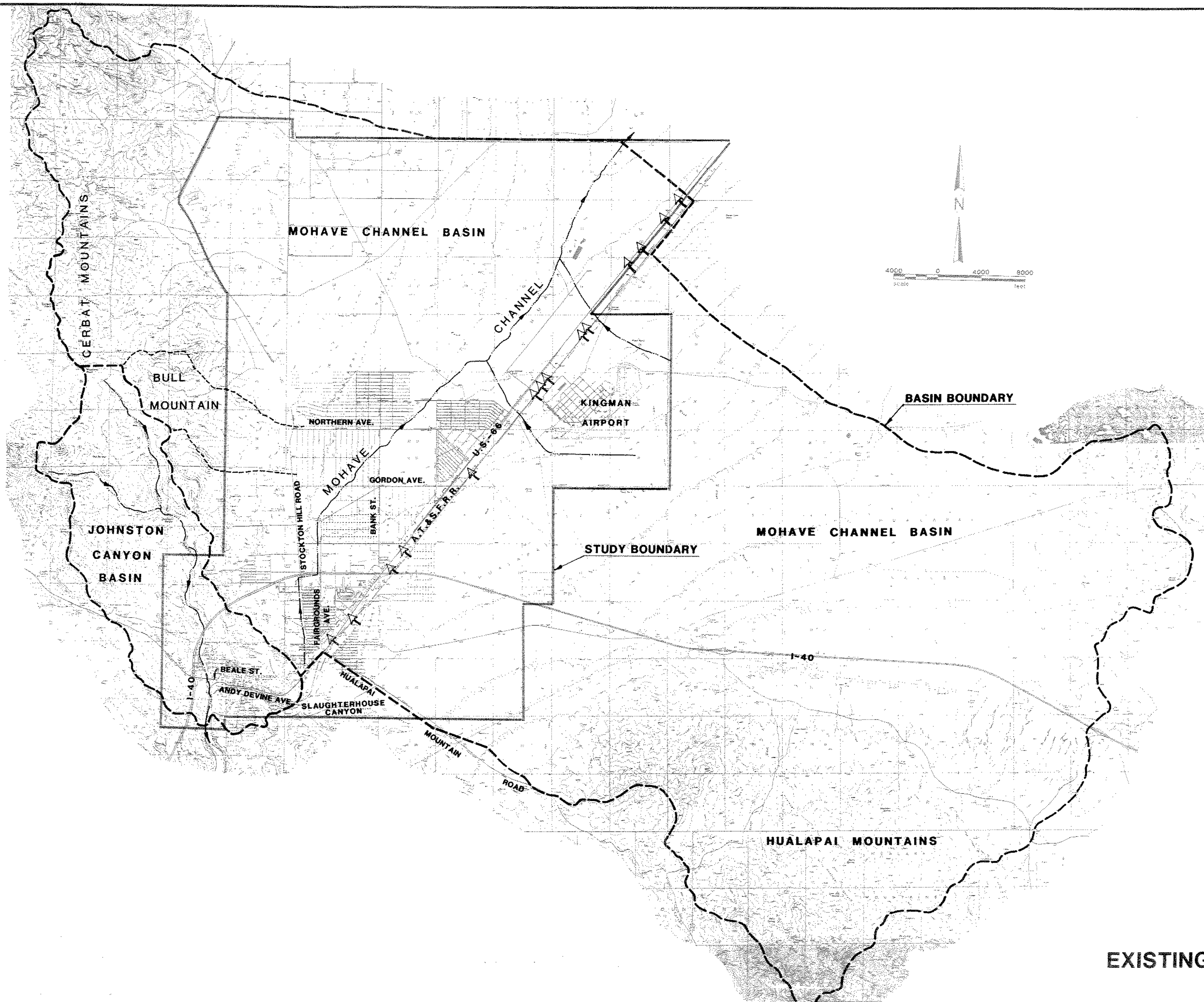
The acquisition of right-of-way should begin as quickly as possible as this establishes a permanent public corridor for future drainage improvements; thereby removing the property from development pressures. Prior to right-of-way acquisition a detailed boundary survey of the channels should be conducted and since right-of-way acquisition will not be possible all at once, the City and County should develop a method of prohibiting construction within the proposed right-of-way.

The simultaneous construction of drainage improvements within the study area is impractical and unlikely. However, improvements are needed and should proceed as shown in Table 3.

Table 3 Proposed Implementation Schedule

1. Adopt Administrative and Design Manual.
2. Identify actual alignment, and conduct field surveys.
3. Prepare legal descriptions and map properties to be affected.
4. Develop and implement a method of prohibiting construction within proposed rights-of-way.
5. Acquire right-of-way as it becomes available.
6. Coordinate new development with the drainage study.
7. Construct the railroad diversion channel proposed along the southeast edge of the AT&SF Railroad right-of-way. Extend the improvements to the Mohave Channel.
8. Improve the Mohave Channel within the area of existing development. This should generally be accomplished from the downstream end proceeding upstream.
9. Construct improvements in other areas of existing development after carefully evaluating the impacts of those improvements on downstream properties.
10. Encourage the construction of improvements within and adjacent to new developments.
11. Evaluate the use of exactions from new developments to share in the cost of drainage improvements.

EXHIBIT 1



EXISTING CONDITIONS

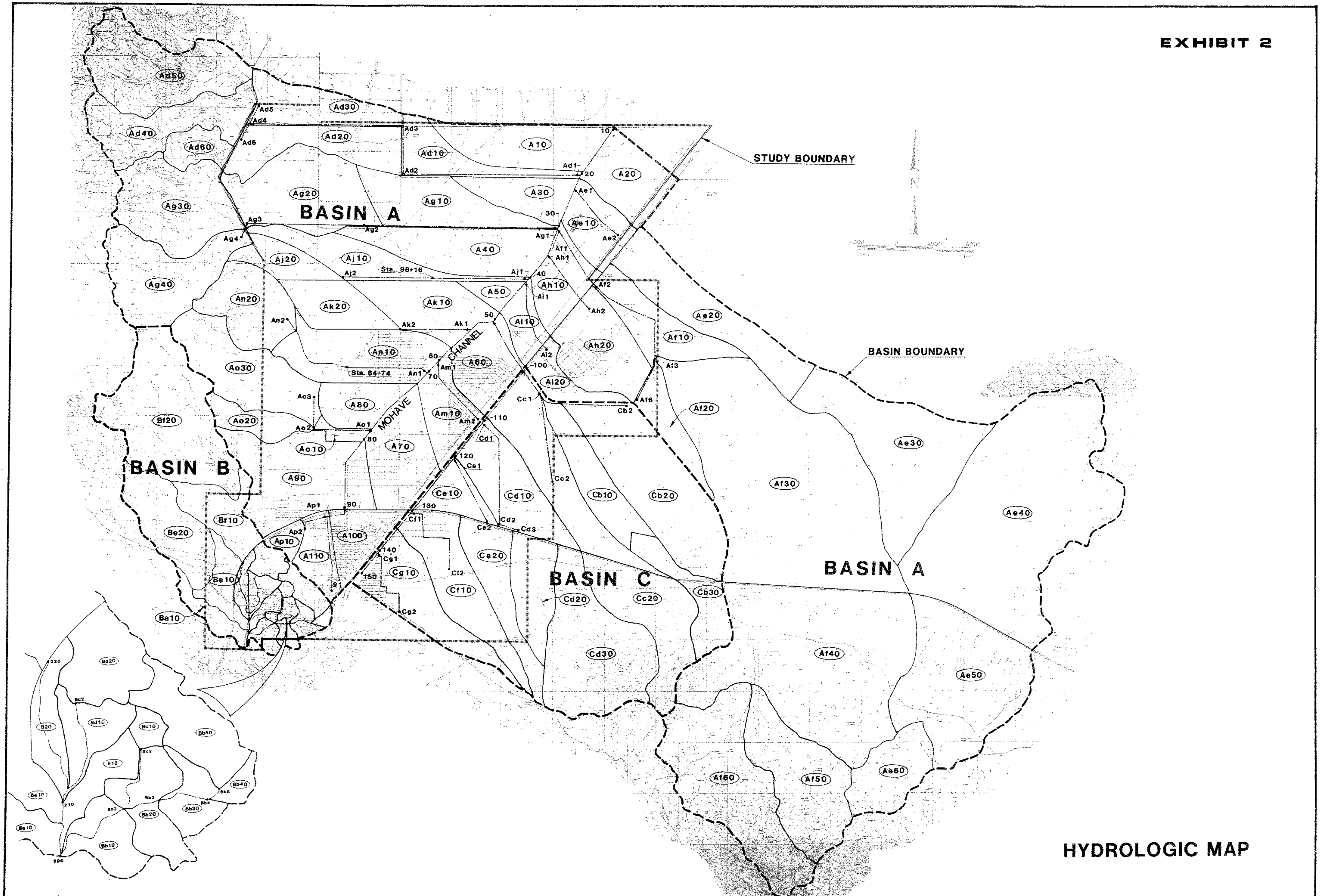
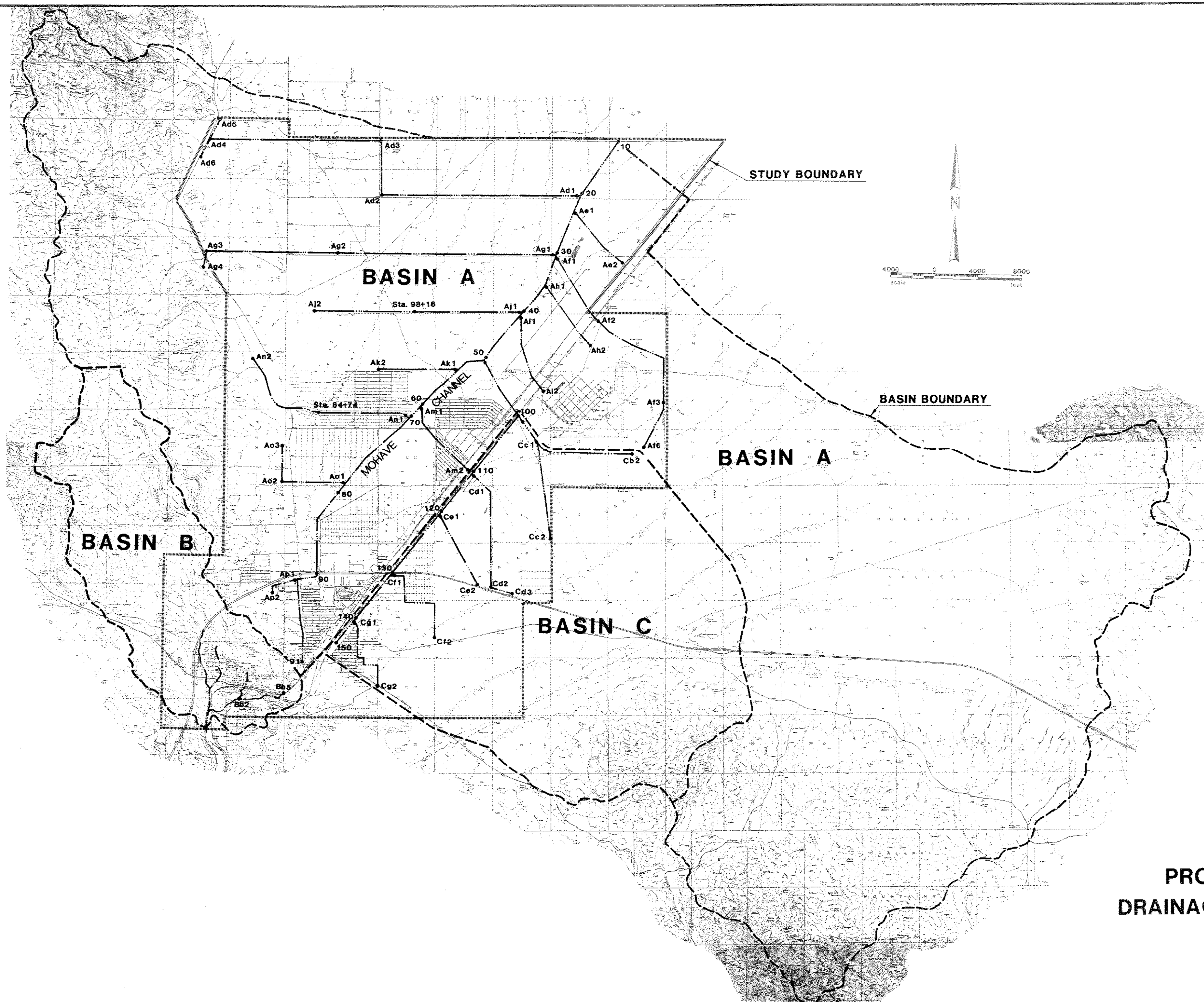


EXHIBIT 2
STUDY BOUNDARY
BASIN BOUNDARY
BASIN A
BASIN B
BASIN C
MOHAVE CHANNEL
Sta. 98+16
Sta. 84+74
N
HYDROLOGIC MAP

EXHIBIT 3



PROPOSED
DRAINAGE SYSTEM